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Alsayed et al.

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(54) **PROCESS FOR MAKING SILVER NANOSTRUCTURES AND COPOLYMER USEFUL IN SUCH PROCESS**

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(58) **Field of Classification Search**

None

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,288,770	A	11/1966	Butler
4,347,339	A	8/1982	Boevink et al.
5,064,730	A	11/1991	Takano et al.
5,470,910	A	11/1995	Spanhel et al.
6,011,160	A	1/2000	Malawer et al.
6,124,415	A	9/2000	Malawer et al.
6,440,637	B1	8/2002	Choi et al.
6,649,138	B2	11/2003	Adams et al.
6,716,895	B1	4/2004	Terry
6,720,240	B2	4/2004	Gole et al.
6,862,396	B2	3/2005	Dickson et al.
7,052,765	B2	5/2006	Lin et al.

(Continued)

FOREIGN PATENT DOCUMENTS

DE	102007018540	10/2008
JP	2003191420	7/2003

(Continued)

OTHER PUBLICATIONS

The Nobel Prize in Chemistry, 2000: Conductive Polymers.

(Continued)

Primary Examiner — George Wyszomierski

(57) **ABSTRACT**

A process for making silver nanostructures, which includes the step of reacting at least one polyol and at least one silver compound that is capable of producing silver metal when reduced, in the presence of: (a) a source of chloride or bromide ions, and (b) at least one copolymer that comprises: (i) one or more first constitutional repeating units that each independently comprise at least one pendant saturated or unsaturated, five-, six-, or seven-membered, acylamino- or diacylamino-containing heterocylic ring moiety per constitutional repeating unit, and (ii) one or more second constitutional repeating units, each of which independently differs from the one or more first nonionic constitutional repeating units, and has a molecular weight of greater than or equal to about 500 grams per mole, is described herein.

6 Claims, 12 Drawing Sheets